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Using Integrated Project Delivery (IPD) to Resolve the Major Construction Project Delay Causes in Saudi Arabia

By

Khalid Abdullah Alkhalid

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_____
Herb Tuttle
Committee Chairperson

_____
Diana Fiddick
Committee Member

_____
Tim Wilcoxon
Committee Member

Date accepted:_____

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Executive Summary

Integrated Project Delivery (IPD) has gained attention in the United States and Europe as an effective delivery method for construction projects. The aim of this research paper is to determine the major causes of delay in projects in Saudi Arabia. This paper also presents recommendations and suggestions for eliminating these causes of delay. In addition, it aims to find out if IPD can be applied to avoid these delays in construction project completion.

Chapter 1: Introduction

Construction projects are rarely completed in the specified time. Unexpected and unplanned issues could occur during the construction and design process that cause confusion and project delay. Construction project delay is a critical problem around the world. The number of projects that exceed their specified time is different from one country to another. Nevertheless, the situation in Saudi Arabia deserves attention.

The Saudi Arabian construction industry has significantly grown on 1980 because of oil revenue (Al-Sedairy 2001). Consequently, the Saudi government put a large percentage of the national development budget into construction projects. “The Kingdom of Saudi Arabia contributed 30% to 40% of the non-oil productive sectors at the end of each national development plan from 1980 to 2000” (Al-Kharashi and Skitmore 2008; Cordsman 2000). However, the government of Saudi Arabia has found that the delay in construction projects, especially the delay in projects related to the public sector, is one of the most

critical problems in Saudi Arabian industry that should be solved (Al-Kharashi and Skitmore 2008).

The delay in construction projects is not a new issue and its causes are well known. Many studies and surveys have been conducted since the 1980s to determine the percentage of delayed projects and the major causes of the delay. In 1983, Zain Al-abidien stated that the total number of delayed projects accounted for 70% of the total projects undertaken by the Ministry of Housing and Public Works (Al-Kharashi and Skitmore 2008; Falqi 2004; Zain Al-Abedien 1983). Al-Sultan designed a survey for the time performance of different types of public projects and found that 70% of the total projects surveyed experienced time overrun (Falqi 2004; Al-Sultan 1987). A survey done by the Water and Sewage Authority in the Eastern province of Saudi Arabia found that between 1985 to 1995, delayed projects constituted 59% of a total of 76 completed projects (Al-Kharashi and Skitmore 2008; Al-Khalil and Al-Ghafly 1999). Falqi (2004) mentioned that some improvements had been achieved over the previous decade. However, he reported that of the 2,379 projects in Saudi Arabia, 952 (40%) were delayed (Al-Kharashi and Skitmore 2008; Falqi 2004). Furthermore, based on the findings of a survey he designed, he noted that “[Saudi Arabia] experienced an average extent of delay that ranges between 131% to over 200%” (Falqi 2004). In a survey by Sadi Assaf and Sadiq Al-Hejji, about 76% of the 23 contractors and 56% of the 19 consultants stated that “the average time overrun for the projects they have experienced is between 10% and 30% of the original project duration” (Assaf & Al-Hejji 2006). The average time overrun for

the projects could reach 30%-50% over that of the original specified duration, according to 25% of the participating consultants in the same study based on their experience.

The American Institute of Architects suggests a complete system and solution to have better control of the projects and deliver them on time, which is called Integrated Project Delivery (IPD). Many successful projects in the United States have used IPD with great results, such as the Sutter Health Fairfield Medical Office Building in Fairfield, California, the Walter Cronkite School of Journalism at Arizona State University in Phoenix, Arizona, and the St. Clare Health Center in Fenton, Missouri.

In Saudi Arabia, HOK (Hellmuth, Obata + Kassabaum), a global architecture interiors, engineering, planning and consulting firm, used IPD to finish one of the most challenging projects in the region, the King Abdullah University for Science and Technology (KAUST). HOK's mission was to design, construct, and build a 3,600-hectare (8,900 acres) university in nine months. Nine months after signing the contract with the Arabian American Oil Company (ARAMCO), HOK finished the mission successfully.

The purpose of this research paper is to describe IPD and apply it to resolving the major causes of construction project delay in Saudi Arabia. Resources for this paper include studies issued in scientific journals, academic research papers, and information provided by institutes in the United States. Because it is not possible to get information in Saudi Arabia about the topic because of bureaucratic and financial constraints, only research papers and

articles done by Saudi academics and people involved in projects in Saudi Arabia will be used for the study.

Chapter 2: Literature Review

Several academic research papers have addressed the causes of project delay in Saudi Arabia. One of the most detailed research papers published on the topic is by Dr. Ibrahim Falqi. He did a survey to determine the major causes of construction project delay in Saudi Arabia and the United Kingdom. Falqi's research paper is titled "Delays in Project Completion: A Comparative Study of Construction Delay Factors in Saudi Arabia and the United Kingdom." Based on a survey, Falqi classified the factors that cause project delay into three categories: owner-related factors, contractor-related factors, and consultant related factors. Table 1-1 shows the most important causes of delay based on the importance index and rank by Saudi Arabia respondents.

Importance index and rank by Saudi Arabia respondents						
No	Causes of delay	RNK	Ctg	IW	R	II
29	Difficulties in financing the project by the contractor	1	C/PF	218	39	5.590
30	Cash flow problems faced by the contractor	2	C/PF	220	40	5.500
43	Delay in the settlement of contractor claims by the owner	3	OWN	216	40	5.400
23	Ineffective planning and scheduling of the project by the contractor	4	C/PM	203	38	5.342
15	Contractor's poor coordination with the parties involved in the project	5	C/PM	211	40	5.275
25	Ineffective control of project progress by the contractor	6	C/PM	188	36	5.222
4	5Changes in the scope of the project	7	EP	203	39	5.205
49	Delay in progress payments by the owner	8	OWN	202	39	5.179
14	Poor communications by the contractor with the parties involved in the project	9	C/PM	200	39	5.128
46	Slow decision making by the owner's organisation	10	OWN	210	41	5.122
31	Problems between the contractor and his subcontractors with regard to payments	11	C/PF	199	39	5.103
19	Poor controlling of subcontractors by contractor	12	C/PM	188	37	5.081
13	Shortage of technical professionals in the contractor' s organization	13	C/PM	193	38	5.079
21	Poor qualifications of the contractor's technical staff assigned to the project	14	C/PM	185	37	5.000
10	Low skill of manpower	15	C/MP	193	39	4.949
22	Improper technical studies by the contractor during the bidding stage	16	C/PM	181	37	4.892
27	Delay in the preparation of contractor submissions	17	C/PM	181	37	4.892
60	Government tendering system requirement of selecting the lowest bidding contractor	18	GR	181	37	4.892

Table 2-1: Importance index and rank by Saudi Arabia respondents.

Source: (Falqi 2008)

As shown as Table 2-1, Falqi ranked the project delay causes under the heading "RNK," and identified the category (Ctg) of the causes based on the project parties, which include the contractor, "C," consultant, "CON," and owner, "OWN." The causes related to contractor performance were subdivided into five groups: materials, equipment, manpower, project management, and project finance. Moreover, Falqi made a calculation to come up with the importance index, "II," importance weight, "IW," and average weight, "AW."

Dr. Falqi explained the table's abbreviations and their meanings as follows:

Abbreviation		Meaning
C		Contractor
Categories related to the contractor	MT	Materials
	EQ	Equipment
	MP	Manpower
	PM	Project Management
	PF	Project Finance
CNS		Consultant
OWN		Owner
Ctg		Category
II		Importance Index
IW		Importance Weight
AW		Average Weight
R		Number of respondents
RNK		Rank
NO		Delay factor's number
m		Modulus of the number of causes in the delay category

Table 2-2: Falqi's abbreviation and their meanings

The results of the survey show that the contractor-related factors category was recognized as the most important cause of delay. Falqi concludes, "[In Saudi

Arabia,] the two most important causes were related to the contractor performance-project finance, difficulties in financing the project and cash flow problems." In addition, other important factors are associated with contractor performance and result in delay. "These are ineffective planning, scheduling, and control of project progress and poor coordination with the parties involved" (Falqi 2004).

The survey results also show that owner performance plays an important role in causing delay in construction projects. The delay in the settlement of contractor claims by the owner was ranked as the 3rd most important cause of delay. Also, delay in progress payments by the owner and slow decision-making by the owner's organization were ranked among the top ten most important causes of delay.

The major strengths of Falqi's study are two. First, the survey had a sizeable number of participants. There were 47 participants who were involved in Saudi construction projects. Second, Falqi classified the causes of the project delay based on their relationship with the construction parties. He designated four categories: "Contractor-related factors," "Consultant-related factors," "Owner-related factors," and "Other."

Another survey related to factors in construction project delay focused on large construction projects in Saudi Arabia. This survey was designed by Sadi A. Assaf and Sadiq Al-Hejji. There were 23 contractors, 19 consultants, and 15 owners who participated in the survey. One of the major strengths of the research paper is that the owners who participated in the survey were big

organizations in Saudi Arabia that have made important large-scale projects in the country, such as Saudi Aramco, Saudi Electricity Company, Eastern Branch, and government departments. Another strength of the study is that the researchers provided every construction party with recommendations to control delays in construction projects.

Data collected were classified and analyzed by frequency, severity and importance. The construction parties' (Contractors, Owners, Consultants) viewpoints were analyzed and used to determine the list of causes of delay. In the study, the researchers concluded that "change orders by owner during construction" is the only common cause of delay that the three parties agree on and found critical. In addition, delay in progress payments by owners, ineffective planning and scheduling of projects by contractors, poor site management and supervision by contractors, shortage of labor, and difficulties in financing project by contractors are important factors that at least two construction parties agree on. Table 1-2 represents the delay causes and their importance.

Importance of delay causes

S. no.	Owners	Contractors	Consultants
1	Shortage of labors	Delay in progress payments by owner	Type of project bidding and award
2	Unqualified work force	Late in reviewing and approving design documents by owner	Shortage of labors
3	Ineffective planning and scheduling of project by contractor	Change orders by owner during construction	Delay in progress payments by owner
4	Low productivity level of labors	Delays in producing design documents	Ineffective planning and scheduling of project by contractor
5	Hot weather effect on construction activities	Late in reviewing and approving design documents by consultant	Change orders by owner during construction
6	Conflicts encountered with sub-contractors' schedule in project execution	Difficulties in financing project by contractor	Low productivity level of labors
7	Poor site management and supervision by contractor	Mistakes and discrepancies in design documents	Difficulties in financing project by contractor
8	Inadequate contractor's experience	Late procurement of materials	Poor site management and supervision by contractor
9	Effects of subsurface conditions (soil, existing of utilities, high water table, etc)	Inflexibility (rigidity) of consultant	Poor qualification of the contractor's technical staff
10	Change orders by owner during construction	Slowness in decision making process by owner	Delay in material delivery

Table 1-2: Importance of delay causes. Source: (Assaf & Al-Hejji 2005)

In Saudi Arabia, the most critical projects are those related to the public sectors and governmental projects because they affect the government development plan and are made to serve the people of the country. Many researchers involved in Saudi construction projects pay more attention to the delay associated with public sector and governmental projects. Adel Al-Kharashi and Martin Skitmore authored one of the research papers on this topic entitled "Causes of Delays in Saudi Arabian Public Sector Construction Projects." The study is based on questionnaires that were given to construction parties to identify the causes of construction project delay. In addition to identifying the causes of delay, Al-Kharashi and Skitmore classified the causes into three categories, which are client-related, contractor-related, and consultant-related causes. Also, they provided some reasons why those causes were associated with Saudi construction projects. The conclusion of the paper is that the delay of payments to contractors, suspension of work, and slow decision-making by the client are some of the major client-related causes. In addition, lack of experience, poor qualifications of the contractor, difficulty in financing projects, conflict between contractors with other parties, and ineffective scheduling of the project by the contractor are the most critical contractor-related causes of delay. Finally, delay in reviewing design documents, and inability to deal with technical requirements are the most important consultant-related causes of delay.

Surely, reducing the problems among the construction parties means eliminating, or at least minimizing, the delay in project completion. Abdul-Mohsen

Al-Hammad, in a research paper, analyzed the interface problems among the various construction parties. He identified 19 common interface problems and classified them into four categories: financial problems, inadequate contract and specification, environmental problems, and other problems. The only problems included that were not found to be related to important causes of project delay in previous studies were environmental problems.

In the study, Al-Hammad found that the most important financial problems are the owner's low budget for construction relative to requirements, delay in progress payment by the owner, and accuracy of the project cost estimate. Second, the most important inadequate contract and specification problems are insufficient working drawing details, and insufficient specifications and violations in the conditions of the contract. Finally, the other important common problems are slowness of the owner in decision-making, and poor quality of work.

Regarding the IPD system, the American Institute of Architects (AIA) published the first version of "Integrated Project Delivery: A Guide" in 2007. The paper gives a close look at what IPD is, why it should be used, and what factors should be considered when using it. Also, it identifies the principles of IPD and addresses the set up of an integrated project, delivery of an integrated project, multi-party agreement and delivery model commentary. In the "Delivery Model Commentary" section, the popular models of delivery, such as design-build and design-bid-build, were identified along with their inherent challenges of integration, particular issues for consideration, and potential ways to address these challenges and issues. The AIA guide will be used to address the problem

of solving and eliminating the project delay causes in Saudi Arabia in this research paper.

In addition to the AIA guide, there are many research papers and case studies about IPD. “Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery,” by David Kent and Burcin Becerik-Gerber, is one of the research papers about IPD and construction projects. In this research paper, the authors provided an explanation of IPD and BIM and included a survey to determine the level of awareness of the professionals in the construction industry regarding IPD. In addition, they explained the characteristics of IPD projects and the early involvement of the IPD project parties. The research paper also discusses the benefits of IPD and preferred delivery methods. The paper has important information and data about factors important for IPD success.

IPD has been used in many projects in the United States. One research paper that could be used as a case study is “Implementing Integrated Project Delivery on Department of the Navy Construction Projects” by Farook Hamzeh, Caroline Clevenger, and Neil Grigg. The authors designed three case studies on existing IPD projects, and provided IPD techniques that could be implemented in their Navy construction project. They concluded that IPD could be used successfully to improve the construction process and add value to construction projects.

IPD could be used to achieve relational contracting which would help the construction parties to increase the level of trust and partnership between team

members, resulting in project benefits and value that extend beyond the project. Jilei Wang conducted research on how IPD could achieve relational contracting through traditional project management methods. Wang referred to many previous studies about IPD and problematic issues in the AEC industry in the research paper's literature review and used the Orlando Utilities Commission (OUC) project as a case study. Wang described the principles and techniques employed by IPD to achieve relational contracting, the ways IPD fosters construction innovation and improves overall project performance, and steps for implementing IPD.

Owen Matthews and Gregory Howell addressed relational contracting and IPD in the research paper "Integrated Project Delivery: An Example of Relational Contracting." They identified four major systemic problems with the traditional contractual approach and discussed the impact of IPD on project delivery and its potential for reaching a solution. They also concluded that IPD is an important relational contracting approach that aligns project objectives with the interests of key participants.

Chapter 3: Statement of the Problem

Delay in the completion of construction projects has become a major concern in Saudi Arabia. More delayed projects means more negative effects on the country's economy and people's quality of life. "The negative effects of the delays are reflected in the cost of developments, the revenue from projects and the quality of those projects" (Falqi 2004). The Saudi Arabian government needs

to accomplish many projects as part of its national development plans. However, only a small percentage of projects are completed on time. Turki Al-Turki designed a survey about project completion in Saudi Arabia and found that only 3% of Saudi Arabia's government projects are completed on time. In addition, he found that 80% of government projects cannot be completed with the funds allocated (Al-Turki 2011).

Objectives of the research

- To provide a general overview of IPD and construction delay in Saudi Arabia.
- Identify the major causes of the construction projects delay in Saudi Arabia based on previous research and provide recommendations for solving the problem.
- To find out if Integrated Project Delivery (IPD) is an effective method that could resolve the causes of project delay based on previous research papers and case studies.

Chapter 4: Integrated Project Delivery (IPD) Overview

What is IPD?

Integrated project delivery (IPD) is a new method and approach for project delivery developed by the American Institutes of Architects (AIA) and based on the "Lean" concept, which was first implemented in Toyota Motor Corporation's

process. It helps the parties involved in the construction projects (architects, contractors, and owners) to work together to reduce cost and waste, avoid conflicts between the parties and deliver a project of the best quality without delay.

AIA defines IPD as “a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.” AIA developed IPD because construction productivity has been declining since 1960, while other industries’ productivity has widely improved.

IPD represents a return to the “master builder” concept as an alternative to traditional delivery systems for designing and building such as design-build, design-bid-build, and construction management. “The Integrated Project Delivery approach became a hybridization of the previous three delivery systems, keeping the Pro’s of each system and eliminating a great number of the Con’s” ("Integrated Project Delivery The best of All the Worlds" 2005).

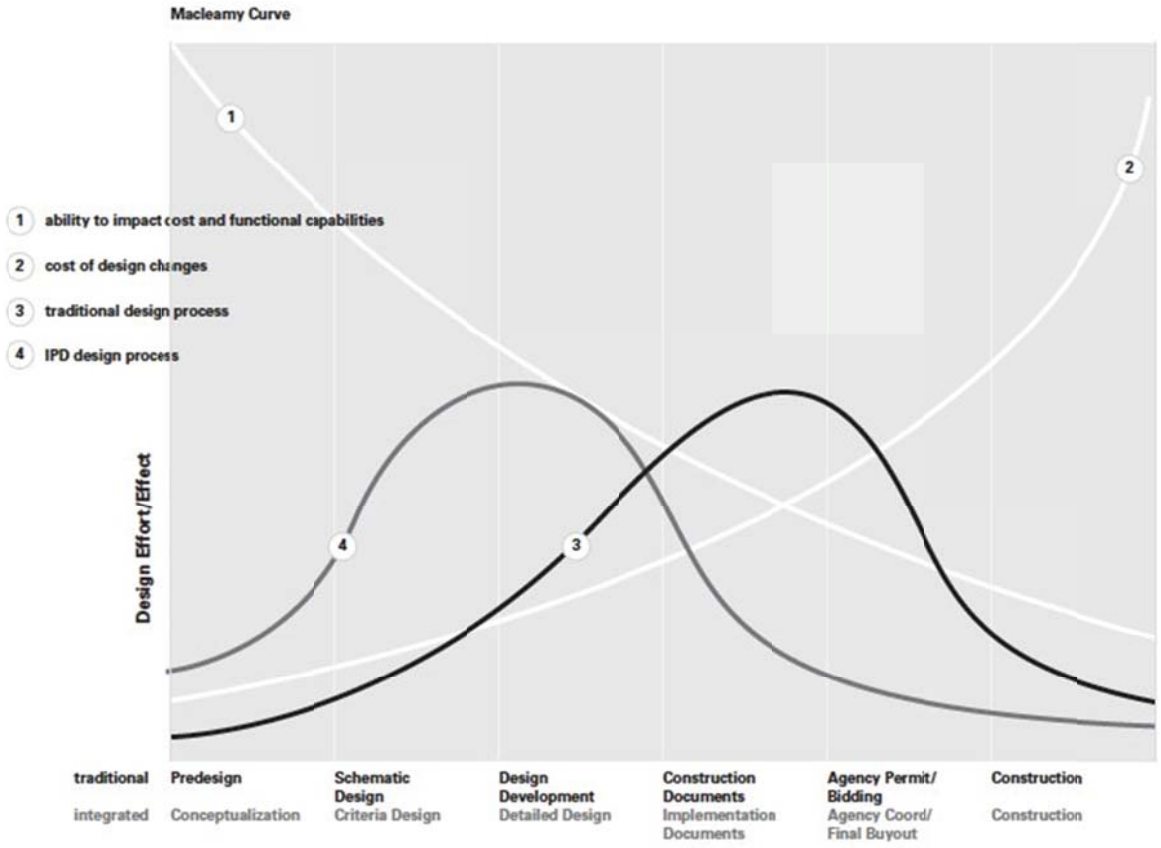

Figure 4-1 Macleamy curve. Source: ("Integrated Project Delivery: A Guide" 2007)

To maximize the value for the owner, IPD brings all the construction project parties and participants together and provides incentives for collaboration at all stages of the process, from the early stages of design, through the detailed design and construction, and until the project finishing process. Unlike the other traditional delivery methods (design-bid-build and design-build), the owner's role and involvement of the project is vital. "The owner's role in initiating and sustaining IPD projects is central and critical, and starts with the first project contract" (Eastman et al. 2011).

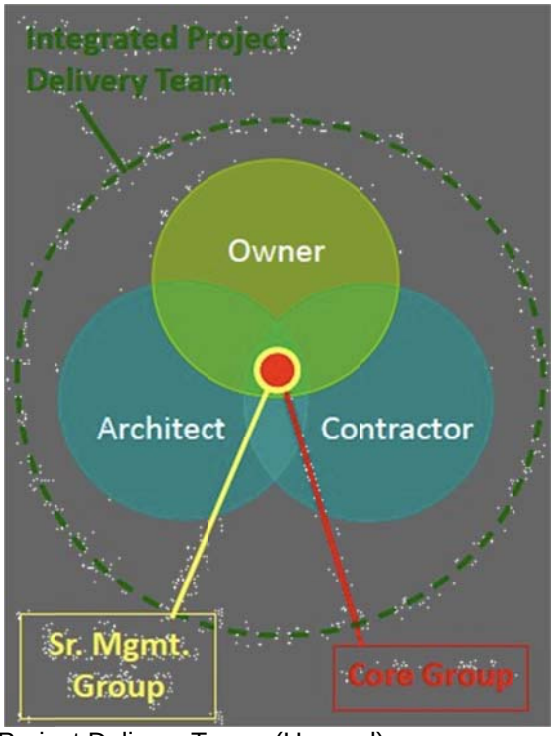

Figure 4-2: Integrated Project Delivery Team. (Howard)

"A non-exclusive list of features includes early involvement of design consultants, the contractor and key trade contractors in preconstruction; utilization of technology like modeling (using a single, shared model) during the design phase by the designer as well as the contractor and key trade contractors to create a three dimensional model for routing and conflict elimination" (Sleight 2011). The parties agree to do their best work and provide all the information available to let all the parties know the details of the project. They also agree to make others aware of all the problems, obstacles and challenges they might face during the project and the solutions and methods that will be used to overcome them. Also, IPD helps to ensure the best quality of the project and avoid project delay. All these advantages make IPD an effective project delivery method.

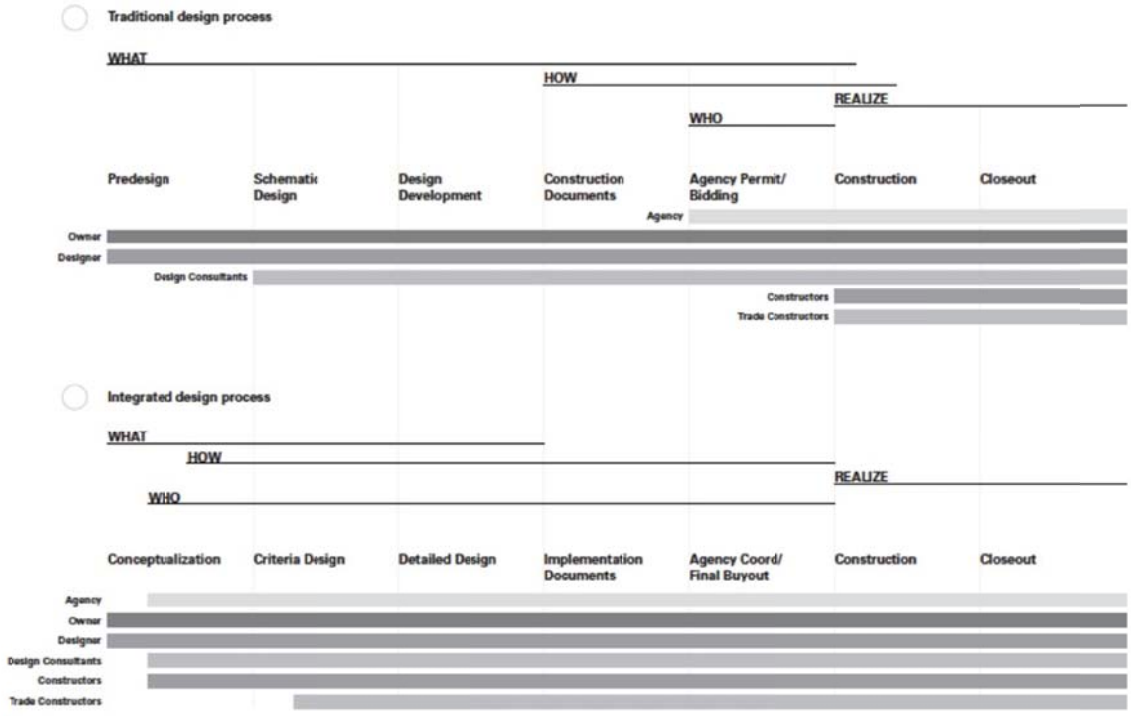

Figure 4-2: Traditional vs. Integrated design process. Source: ("Integrated Project Delivery: A Guide 2007")

IPD Considerations

In order to implement IPD, systems need to be changed and new technologies need to be used. The traditional way of project delivery and the traditional relationship between the project parties should be modified. The project parties should be open and ready to share all the information about the project at all stages. Also, it is important that the project parties agree and perform all nine IPD fundamental principles, as described and explained by AIA, which are "Mutual respect and trust, Shared risk and reward, Collaborative innovation and decision making, Early involvement of key participants, Early goal definition, Intensified planning, Open and enhanced communication, Appropriate technology, and Virtual organization and leadership" ("Integrated Project

Delivery: A Guide" 2007).

What Is Building Information Modeling (BIM)?

Building Information Modeling (BIM) is a software program that allows the project team to see the details of the projects by including graphical drawings, specification, and schedules. Unlike AutoCAD and other traditional drawing software, BIM treats the lines as models with detailed information. "The following are a few of the more widely accepted definitions by the manufacturers of the mainstream BIM software.

- "A single repository including both graphical documents- drawings- and non-graphical documents- specification, schedules, and other data." - ArchiCAD
- "A modeling of both graphical and non graphical aspect of the entire building Life cycle in a federated database management system" – Bently
- "A building design and documentation methodology characterized by the creation and use of coordinated, internally consistent computable information about a building project in design and construction." – Autodesk" (Vogt 2010)

The manufacturers of BIM software made different versions of the program for the architects and engineers involved in construction projects. For example, Autodesk released Revit Architecture, Revit Structure, and AutoCAD Revit MEP Suite. These programs help all the project parties reduce drawing errors when combining the models, and allow them to store the last updated versions of

needed documents. “The goal for BIM is to allow information to be stored centrally, updated quickly, and accessed by multiple stakeholders” (Glick). Implementing that goal makes BIM an ideal tool for using Lean techniques that help reduce waste and cost. “Some spinoff uses for BIM are being experimented within industry and include 4D modeling which adds scheduling to the model, 5D modeling which adds scheduling and costs to the model, and conflict detection and planning by sub-contractors” (Glick).

One of the most important advantages of BIM is visualization. “All BIM programs can represent a building with a three-dimensional model” (Glick). This feature helps the stakeholder to understand exactly what the building will look like after it is built. Unlike with other traditional drawing software, stakeholders do not need extensive knowledge in the engineering field to understand the model. “BIM models can also include selected embedded information concerning building geometry, materials, specifications, code requirements, assembly procedures, prices, manufacturers, vendors, and any other related data associated with how the object is actually used” (Glick; Ibrahim & Krawczk 2003).

The relationship between IPD and BIM

BIM has become a crucial tool for IPD as it helps the project parties to consider many of the IPD fundamental principles. BIM can help the project parties to consider the “Shared risk and reward” principle because BIM allows all the project parties to work together and make decisions based on what they see in the BIM model of the project. The project parties can see any problem occurring in the model and can make decisions based on what they see.

In addition, BIM can be used to achieve the “Collaborative innovation and decision-making” principle because the project model helps the architects and engineers to come up with solutions to problems they might see during design and construction. Architects and engineers are able to see one model of the building instead of many confusing drawings that might have errors or very technical details. They can communicate and come up with unique and innovative solutions to problems and make the appropriate decisions.

Moreover, BIM helps the construction parties to integrate the “Intensified planning” principle into the project. The multiple versions of BIM for architects and engineers help the designers, contractors and owners to visualize their project model and take early planning steps together by defining the opportunities and the challenges they might face.

Additionally, BIM is effective software for the project parties’ communication because by using the BIM models, it is easier for the designers and contractors to explain the model of the project to all the stakeholders. This feature helps the construction parties to apply the “Open and enhanced communication” principle for their project.

Finally, BIM is the widely accepted technology for IPD because it is fast, can include documents and details, and helps the project parties interact with one another as they use it. BIM could be considered as the “Appropriate technology” for IPD projects.

In conclusion, BIM is an important and effective tool of IPD. The technology helps construction parties apply the major IPD principles to the

project by providing needed project details, including the building model, specifications, and cost and schedule. It is not the only technology that could be used in IPD projects, but it is the most popular one.

Chapter 5: The Causes of Construction Project Delay in Saudi Arabia

Based on studies done on construction projects in Saudi Arabia and as discussed in the literature review, the major causes of construction project delay in Saudi Arabia can be classified into four categories: bidding-related, financial-related, inadequate contract and specifications-related, and other factors. These categories were chosen because they include the factors ranked as the top ten causes of the project delay in the Falqi, Assaf and Sadiq Al-Hejji, Al-Kharashi and Skitmore, and Al-Hammad research papers.

Bidding-related factors	**Financial-related factors**	**Inadequate contract and specification-related factors**	**Communication and coordination-related factors**
Shortage of labor	Difficulties in financing the project by the contractor	Ineffective planning and scheduling the project by the contractor	Contractor's poor coordination with the parties involved in the project
Unqualified work force	Cash flow problems faced by the contractor	Ineffective control of the project progress by the contractor	Change in the scope of the project

Inadequate contractor experience	Delay in progress payment by the owner	Insufficient working drawing details	Poor communication by the contractor with the parties involved in the project
Poor qualifications of the contractor's staff	Accuracy of project cost estimate	Insufficient specification	Slow decision-making by the owner's organization
	Owner's low budget for construction relative to requirements		

Table 4-1: The major construction delay causes

1. Bidding-related factors

Four sub-category causes could be classified under the bidding-related factors. They are shortage of labor, unqualified work force, inadequate contractor experience, and poor qualifications of the contractor's staff. All the previous research papers mentioned those causes. Even though those factors are related to the contractor's experience and qualifications, the owner and the bidding system in Saudi Arabia also play an important role in contributing to the existence of these factors. Falqi explains the bidding system in awarding the contracts and how that system affects the projects' duration. "Adopting the tendering system of selecting the lowest bidding contractor in public projects may mean accepting a contractor with poor qualifications or a shortage of resources. This may lead to poor construction performance and delays in project progress. Additionally, this strategy discourages contractors from mobilizing the best efforts

and resources they have in order to win the bidding competition" (Falqi 2004).

Assaf and Hejji also mentioned the problem of the bidding awarding system in Saudi Arabia and its effects on the project duration and quality. "Consultants, like owners, assign awarding the lowest bidder as the most frequent factor of delay. This is due to that most of owners award the lowest bidder to execute their projects. Generally, the lowest bidders are unqualified contractors with shortage in resources and low capabilities, which lead to low performance and which cause delay in completion of the work" (Assaf and Hejji 2005).

The owners who use that bidding system may not be aware of the contractor's resources and qualifications. The awarded contractors might be unqualified and have a shortage of resources. Therefore, many problems and conflicts between the project parties will occur during the project and cause delay. As Al-Hammad explained, "Skilled labor is required to complete high quality work. Labor may not clearly be mentioned in the bid documents; however, a shortage of this important resource will affect the quality of the completed work and thus create a conflict among the construction parties" (Al-Hammad 1993, 1995).

In conclusion, awarding the projects to the lowest bidder is not a good system for avoiding project delay. That system could award projects to unqualified contractors with a shortage of resources. As a result, the system will cause all the bidding-related factors that affect project duration, including shortage of labor, unqualified workforce, inadequate contractor experience, and poor qualifications of the contractors' staff.

Recommendations to avoid bidding-related factors

To avoid or minimize bidding-related factors, the owners should award their projects to qualified contractors that have enough resources and capabilities and who understand the project type, characteristics, and specifications. It is recommended that the owners look for qualified contractors rather than award the projects to the lowest bidder. If that is impossible, Assaf and Hejjii suggested checking the resources and capabilities of all the bidders before awarding the contract to the lowest bidder (Assaf and Hejji 2005).

2. Financial problems

Five financial-related factors were mentioned in the previous studies and were ranked as some of the most serious causes of delays. These are difficulties in financing the project by the contractor, cash flow problems faced by the contractor, delay in progress payment by the owner, accuracy of project cost estimate, and the owner's low budget for construction relative to requirements. These factors can be classified into two categories as shown in Figure 5-1: factors caused by the contractor, and factors caused by the owner.

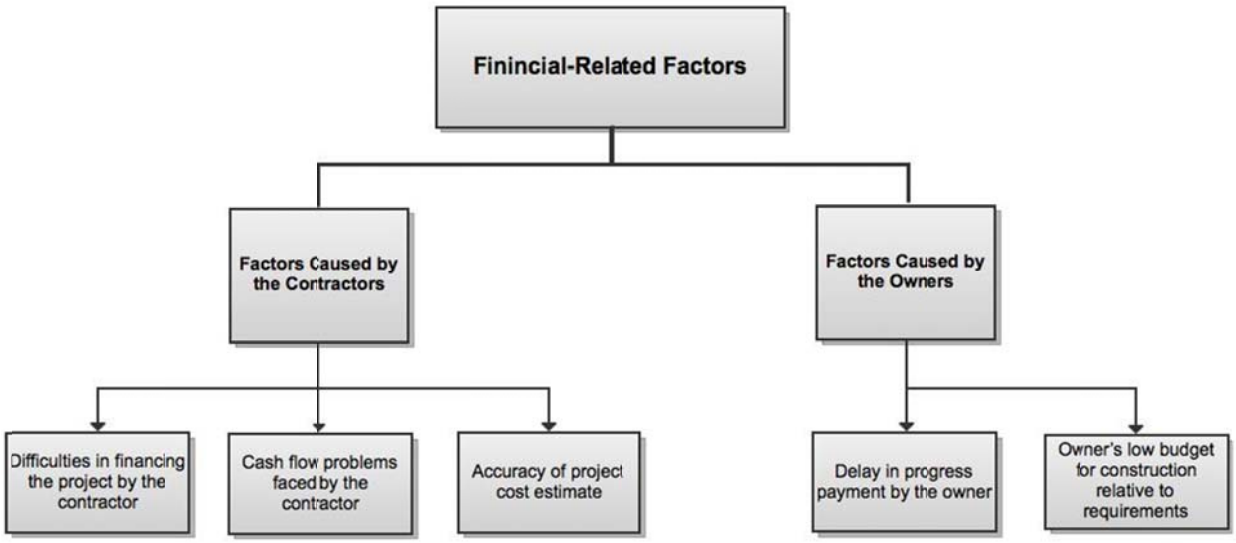

Figure 5-1: Financial-Related Factors

The factors caused by contractors are difficulties in financing the project, cash flow problems, and accuracy of project cost estimates. Falqi explained how the factors caused by contractors occur: “What happens in the Saudi construction industry is that many contractors bid for projects that are above their financial capacity as they think they will distribute the work to many subcontractors. Still, some of owners require a financial guarantee to prove that the contractor is capable to carry out the project; however, some contractors take a loan in order to provide a bank guarantee, but at the end of the day, they find themselves lf committed financially with many parties, facing great difficulties in financing the project, and they may not able to manage the project cash flow” (Falqi 2004).

The contractors who bid for projects that are above their financial capacity are not qualified contractors of the project. Nevertheless, sometimes the contractors think they will be able to do a project and take the risk of getting a

loan, only to realize that they have made inaccurate estimations on the project or have misunderstood the specifications and requirements of the project. As a result, they experience difficulties in financing the projects they are involved in and face cash flow problems.

On the other hand, owners play an important role in causing delay in projects when they are slow in making progress payments. This problem might occur because of bureaucracy and the lengthy process some owners have to go through to make payments. Many departments in the owners' companies are involved in reviewing each contractor's payment, which is often a long process. (Al-Kharashi and Skitmore 2008). The delay in payments by the owner affects the contractor's financial plans and results in slow progress of the project.

In addition, the owner's low budget for construction relative to requirements is another major factor that often happens because of the owner's lack of awareness of construction costs. "In the construction process, owners face high construction costs and thus would like the designer to modify the design in order to cut costs" (Al-Hammad et al. 1996; Bennett 1981). It is important that the owner have the details about the construction costs in the design stage and before starting the project. Otherwise, the owner must deal with over-budgeted projects by making changes during the construction, which would cost the project time.

Recommendations to avoid financial-related factors

There are two recommendations that contractors need to consider to avoid financial-related factors. As Falqi suggested, "The contractor should make

sure that he has sufficient capital to enable him to undertake a specific project, and put all financing processes under control by adopting an effective project financing method" (Falqi 2004). It is important for the contractor to understand the project specifications and make sure that the resources fit the project.

Another suggestion for contractors is to have a system, or software, that could help them to make more accurate cost estimates based on the project characteristics and specifications.

Regarding the owners, three recommendations need to be considered. First, the owner should have an improved system to review the contractor's payment and the construction stage. Second, another system should be made to analyze the design and construction costs in the early stages of the project before making any decision. The system should show the specifications of the building materials, and the construction cost information side-by-side to give the owner a better idea of the project budget. Finally, the owner needs to be told and should understand the technical issues that might be required for the project that will raise the cost of construction. This information should be communicated in the early stages of the project during the detailed design.

3. Inadequate contract and specifications problems

Inadequate contract and specifications problems can be summed up by four factors: ineffective planning and scheduling the project by the contractor, ineffective control of the project progress by the contractor, insufficient working drawing details, and insufficient specification. These factors seem to be related to each other. When there is insufficient specification and working drawing details,

the contractor has difficulties in planning, scheduling and controlling the project progress. Falqi explained how these factors occur: “Ambiguities, mistakes and inconsistencies in the specifications and drawings will lead to many stoppages during construction, and therefore a longer project duration. Furthermore, unclear specifications and drawings may not give the owner a clear picture of the project, and increase his surprise at the construction stage, which in turn will result in adversarial disputes and changing orders” (Falqi 2004). Therefore, it is important to make clear documents for the project specifications and working details that will be reviewed and agreed upon by the project parties as early in construction as possible. All the project parties should understand the technical specifications and agree on them before estimating costs and scheduling to avoid future problems. “The bid documents, which include technical specifications, and other documents are the basis of the agreement between the owner and contractor. If the bid documents are incomplete or unclear, the following may occur: (1) the contractor will attempt to minimize cost and maximize profit at the expense of the project; (2) the owner will attempt to maximize the amount of work; and (3) the conflicting objectives will lead to disagreement and the possibility of delays in the completion of the project” (Al-Hammad 2000; Al-Hammad 1995).

Nevertheless, the unqualified contractor could make that action useless. Even with the perfect drawing details and specifications documents, the contractor who lacks experience and does not have the skills required to perform adequate scheduling and project control cannot deliver the project on time.

In conclusion, “Drawing details and specifications are the only means for the contractor to comprehend the job requirements” (Arain et al. 2006; Kostoff 1977; Chappell and Willis 1996). It is important that the contractor who is involved in the project is skilled and receives all the correct and necessary information to have better control of the project.

Recommendations to avoid inadequate contract and specifications-related factors

After a qualified contractor has been found for the project, the most important and effective way to avoid inadequate contract and specifications factors is to review all the needed documents and agree on them in a very early stage of the project. All the documents and information should be clear for all the project parties before starting the detailed design stage. “In actual fact, spending enough time at the early planning and design stage can speed the progress of production and avoid sinking into a ‘disputes and blame’ culture. Basically, paying careful attention to the early stages of the project will result in completing the project earlier than planned or on time” (Falqi 2004). As mentioned earlier, making changes in the early stage of the project costs less than making changes during construction.

4. Coordination and communication problems

Five major causes in construction project delay were found in the previous studies that could be related to coordination and communication problems: contractor’s poor coordination with the parties involved in the project, change in the scope of the project, poor communication by the contractor with the parties

involved in the project, slow decision-making by the owner's organization, and poor planning and scheduling of the project parties. Success in completing building projects depends mainly on proper coordination, cooperation, and communication among construction parties (al-Hammad 2000). All project parties should take the responsibility to have a clear communication during the project stages to deliver the correct information to each other and have better project coordination. Nevertheless, the contractors often have the biggest responsibility to improve the communication and coordination with the project parties. "Contractors' responsibilities involve many tasks that contribute to project management performance. Planning and scheduling the project, communication and coordination with project parties, controlling suppliers and sub-contractors are the main issues that impact on project duration" (Falqi 2004). When the contractor fails to provide good communication and coordination, the other project parties, especially the owner, can become confused about the problems that may occur during the construction. Al-Kharashi and Skitmore described some of the problems caused by the contractor's poor communication and coordination in Saudi Arabia. "The client, in this case the government, is often unaware of technical issues and simply passes on its tasks to the consultant. This matter has led the client to be unaware of what is happening on the site itself. This aspect reduces the ability of the client to take decisions that may facilitate the construction process. Poor daily communication between the client and consultant and lack of experience of the client's technical staff tend to exacerbate the situation" (Al-Kharashi and Skitmore).

When the contractors achieve good communication and coordination with the project parties, the change in the scope of the project is less, the decision-making is faster, and the planning and scheduling between the project parties is improved.

Recommendations to avoid coordination and communication-related factors

The project parties need to have a method to allow them to deliver and receive the correct information. That method should help them to reach each other quickly, understand each other, and work together to make appropriate decisions in the early stages of the project.

Chapter 6: Using IPD to Resolve Project Delay Causes

In this chapter, IPD will be applied to find out if it could be used as a process to eliminate or avoid project delay factors. Using the previous studies about IPD, the IPD process and its tools will be analyzed to see if it can help the project parties to fulfill the Chapter 5 recommendations.

Avoiding the Bidding-Related factors

As mentioned earlier, owners should award their projects to qualified contractors to avoid delay causes associated with bidding-related factors. IPD has a requirement for the project parties. They should work together as a team from the beginning of the project until the end. All of the project parties, including the contractor, should have the qualifications and resources that help them to be involved with the IPD process. In addition, they should agree on a contract that

would help them work together in the early stages of the project and apply IPD principles. Moreover, the contract will help to enhance the early involvement of key personnel, open information exchange, sharing knowledge and expertise, sharing risk and reward based on project outcome, and joint project management to achieve shared goals (Ashcraft et al.). This type of contract is called a "Relational Contract." Owen Matthews and Gregory Howell (2005) concluded in their study that IPD is a solution to complicated contracting and organizational problems. It helps the project parties to reduce waste and increase value for the owner by applying the Lean production practice into the project. "IPD is a Relational Contracting approach that aligns project objectives with the interests of key participants. It creates an organization able to apply the principles and practices of Lean Project Delivery system" (Matthews et al. 2005).

AIA has designed standard contracts such as ConsensusDocs 300 series to ensure that project parties apply IPD principles in the project. The IPD contract defines the tools that project parties need to use. "IPD contract usually defines the BIM software tools the various team members will use, and the information-sharing server solutions the project will support for the benefit of the project as a whole" (Eastman et al. 2011). The IPD contract helps to identify the type of the contractors needed in the project and the tools that the contractors need to use during the project.

In addition to the AIA contracts, the Associated General Contractors of America (AGC of America) have published a document that explains the Qualification Based Selection of Contractors (QBS) method, which could be used

effectively in the rational contracting and help the project parties to implement the IPD delivery method. “QBS will greatly enhance the opportunity for success in all delivery methods because the early involvement of all team members at the earliest, critical meetings embraces and promotes teamwork, collaboration, innovation, sustainability, and utilization of technology such as Building Information Modeling (BIM)” (“Qualifications Based Selection of Contractors” August 2009). QBS has selection criteria such as the contractor qualifications, demonstrated competence, financial strength and bond capabilities, and capacity to perform work (“Qualifications Based Selection of Contractors” August 2009).

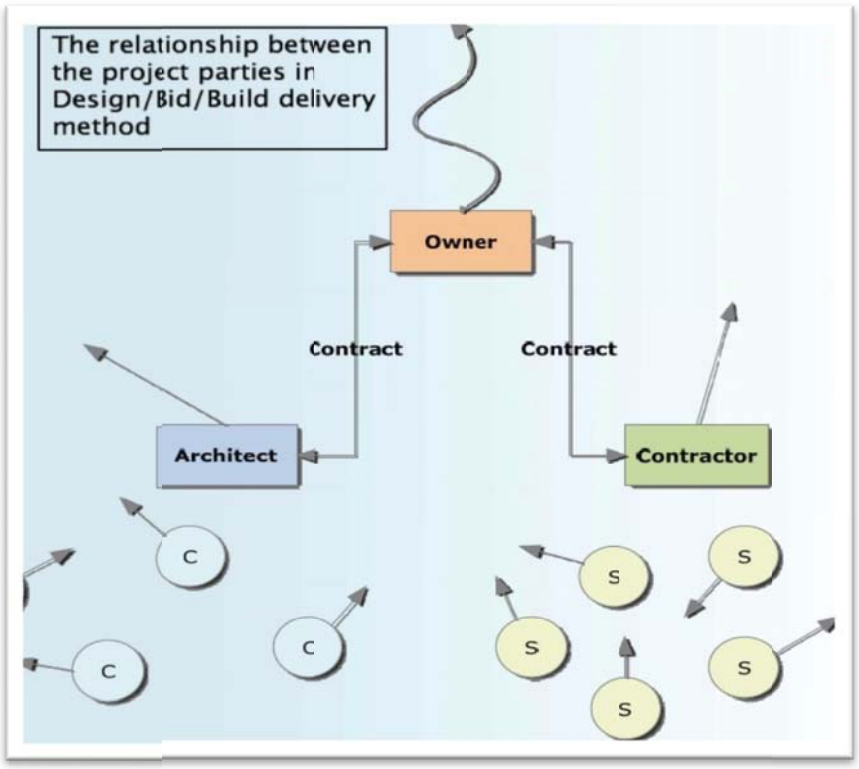

Figure 6-1: The relationship between the project parties in the traditional delivery method. (Howard)

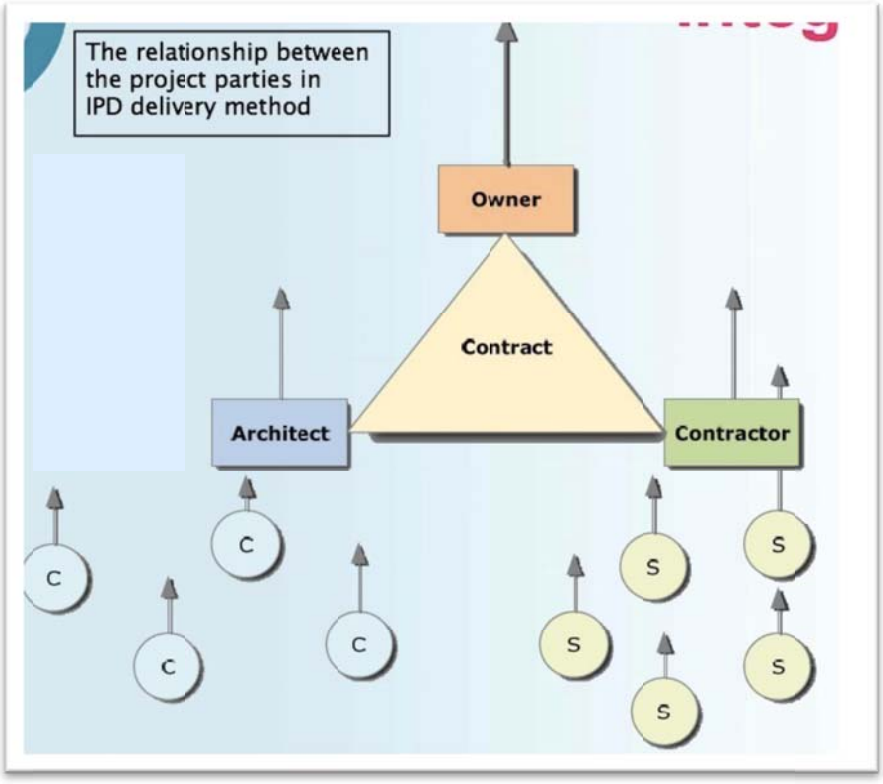

Figure 6-2: The relationship between the project parties in an IPD project. (Howard)

Owners would have greater outcomes if they avoided the design-bid-build delivery system that awards the job to the contractor with the lowest bid. Instead, the owner should work on selecting a project team that can work as a highly collaborative group. In this way, the designer and contractor, in addition to the owner, become more aware about the project specifications and the resources needed to complete the project. The design-build delivery system helps the owner to make a team-based group because it requires that the parties work together on the project as a single party. However, owners will be less involved in the project process than they would be when using the IPD delivery method. Peter Jensen (2011) explained IPD and described one scenario in which the method was used to choose the project team. “In an Integrated Project Delivery

(IPD) method, the owner contracts with all concerned parties in a way that all parties are engaged to work collaboratively to complete the project. This method integrated people, system, business structures and practices to collaboratively harness the talents and insights of all participants" (Jensen 2011).

In conclusion, owners will be better able to choose the appropriate contractor for the project when they decide to implement IPD and use contractor selection methods such as QBS to avoid the bidding-related factors of delay in construction projects.

Avoiding the Financial-Related Factors

There are five goals that IPD should achieve to avoid the financial-related factors. The first two are related to the contractor. First, contractors should make sure that they have enough resources and the capability to undertake the project. Second, contractors should have an appropriate system or software that could help them to make a more accurate cost estimation of the project. IPD allows the project parties to sit together and share information about the project details and specifications during the early design phases. In addition, the BIM tool helps the project team to see the model of the project in detail including the material specifications that will be used, the schedule information, and technical equipment. "BIM allows for an estimator to pull a fairly accurate bill of materials and square footages of spaces at any point in the design process for use in estimating" (Jensen 2011). In addition, other programs such as Application Programming Interface (API), ODBC connection, and Excel can help in getting detailed information on quantities and material definitions from BIM.

By using those programs along with BIM, the contractor can have more accurate information and estimation about the project and help contractors compare the resources they have to the model specification. Not only that, BIM can help contractors to understand the changes in design and analyze them to see if they can implement the changes or not. As a result, contractors can decide if they can handle the project or find other solutions with the other members of the project team.

The other three recommendations are for the owner. First, owners should have an improved system that helps them, to review the contractor's payment and construction phase. Many organizations are developing technologies to help the owner to review the project information and process without spending time on going to the site or attending the meeting physically. One of the technologies that could be used is "Projectmates." It is a secure internet-based system that allows the project team to share the project information including the "BIM-based" project model, project schedule, construction pictures, and all other documents at a single location. All the project team, including the owner, will be allowed to access and post information to track the construction process and send payments to the contractor.

The second recommendation for owners is to implement a system or software that allows them to analyze the design and construction cost in the project's early stages before making the decision to begin construction. As explained earlier, BIM is ideal software for cost estimation for the owner as well as the contractor. The project team can build the project model with all the

project specifications and do the estimations and analysis needed to predict the cost of the design as well as the construction. In addition, it will be easier for the owner to make the changes in the project model and design to fit the owner's budget before starting the construction.

The third recommendation for the owner is to find a method that can help the project team to explain some technical issues in the project before approving it. The owner might not have the experience and the skills to understand some of the architectural and engineering details. IPD and BIM also help the project parties to deliver the information accurately to the owner, as well as the other project parties, by creating a preview of the project model and all the technical information as a look-like model. Figure 6-1 compares a picture of a BIM model of plumbing details with a real picture of the Sutter Medical Center Castro Valley.

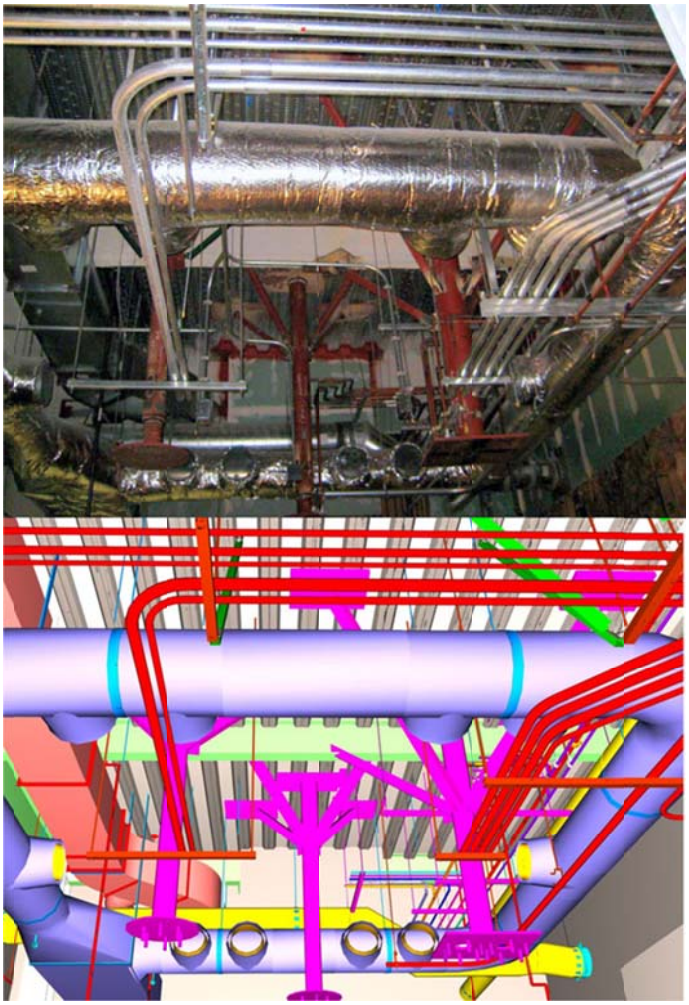

Figure 6-3: A real picture of the plumbing equipment in Sutter Medical Center Castro Valley compared with a snapshot of a BIM-based model. Source:

In summary, IPD and BIM, used along with other technologies, can help the contractor and owner avoid the financial-related factors of project delay. By previewing the model of the project in the early project phases, the contractor and the owner will have a better idea about the construction project estimation and can make the appropriate actions based on it. Also, the owner can access the project information and review the construction phase quickly, which would make the payment process to the contractor faster.

Avoiding the Inadequate Contract and Specifications-Related Factors

It is recommended that the project team spend enough time early in the planning phases reviewing all the necessary project documents and agreeing on them to avoid the inadequate contract and specifications-related factors. As explained earlier, IPD and BIM can help the owner and contractor to predict the cost estimation of the project based on the project specifications and the owner's requirements. Nevertheless, IPD and BIM can ensure that all members of the project team, including the sub-contractors, provide information about their products' cost in the early stages to be considered and factored into the decision-making process. The sub-contractors can also provide alternatives for their products if the project core parties find them expensive. Some companies in the United States have websites that allow them to upload their BIM-based products. One of the websites providing this service is "smartbim.com." On this website, the core project parties can choose a brand and download the object they want for free, along with all the information about it. They then can apply it in their project model and make decisions based on the information they have.

In conclusion, BIM helps the designer to provide detailed and correct working drawing details with specifications, which are approved by the owner, to the contractor. Also, the project parties can confirm the cost and details of the sub-contractors' products and approve them before doing the construction. As a result, the contractor will have all the information needed to make effective planning and scheduling, and should be able to control the project process.

Avoiding the Coordination and Communication-Related Factors

The project parties should have an effective method for communication to ensure better coordination during the project and avoid project delay factors. “One of the largest obstacles to the timely sharing of information is the lack of software integration in the industry. There are several area-specific software programs that are stand alone but not one industry-wide system to facilitate smooth transfer of information” (Glick N.D; Alshawi & Ingirige, 2003). New technologies are making communication easier. “BIM seeks to facilitate the exchange of information between all parties to a construction project, with the goals of reduced cost, error, and redundancy” (Glick 2004). As explained previously, BIM helps the project parties to make better estimations and present all the other information about the project more effectively. In addition to providing a 3D model of the project, BIM also provides “4D modeling which adds scheduling to the model, 5D modeling which adds scheduling and costs to the model, and conflict detection and planning by sub-contractors.” These models are also able to contain “selected embedded information concerning building geometry, materials, specifications, code requirements, assembly procedures, prices, manufacturers, vendors, and any other related data associated with how the object is actually used” (Glick N.D; Ibrahim & Krawczyk, 2003). However, IPD is not only BIM. IPD is a process that all members of the project team should be aware of to help them work together to complete the project as desired. Table 6-1 shows the percentage of projects in which each party is involved at the corresponding project phase. In contrast to the traditional delivery system in

which some team members are only involved in the construction stage, all of the project parties are involved in the project from the preliminary design until the close out and facility management phase in IPD.

Table 1. Involvement of Project Team Members during Stages of a Project

	Preliminary design (%)	Early design (%)	Design development (%)	Construction (%)	Closeout (%)	Facility management (%)
Owner	94.3	85.8	84.9	82.1	72.6	71.7
Architect	92.3	89.4	92.3	82.7	67.3	15.4
Engineers	71.0	86.9	91.6	85.0	60.7	19.6
General contractor	46.7	69.2	82.2	89.7	76.6	23.4
Subcontractors	17.1	41.9	72.4	89.5	67.6	22.6
Manufacturers/suppliers	11.8	41.2	74.5	87.3	48.0	23.5
Specialty consultants	43.1	69.6	83.3	79.4	46.1	28.4

Table 6-1: Involvement of Project Team Members According to the Stage of a Project. Source: (Kent 2010)

IPD requires the project parties to share all the information about the project and make it accessible to each other. New technologies are helping to exchange this information digitally rather than on paper. That means the project parties can have access to the project information at any time and any place, making the process faster. In addition, IPD requires the project team to share the risks and rewards, which will encourage all the members of the project team to facilitate effective communication to save time and resources. Furthermore, technologies are helping them to communicate more effectively in a shorter amount of time. “Regular meetings among all of the team members in the IPD approach are accomplished using Internet programs such as ‘Go-To-Meeting’ or ‘Web-Ex.’ Team members are able to visually share the project model and other

documents simultaneously, while discussing project issues. Using these programs, attendees have the ability to control and mark up the screen as they troubleshoot problems and develop solutions. The meetings can be recorded and then stored for future reference, if needed" (Fagent n.d.). Moreover, because all the information should be accessible and available, the project parties can work on their tasks at the same time rather than having to wait for a response from the other parties. Also, the communication methods using the new technologies are available to get quicker responses and decision-making. With all these tools, the communication between the IPD project parties will be improved in all the project phases.

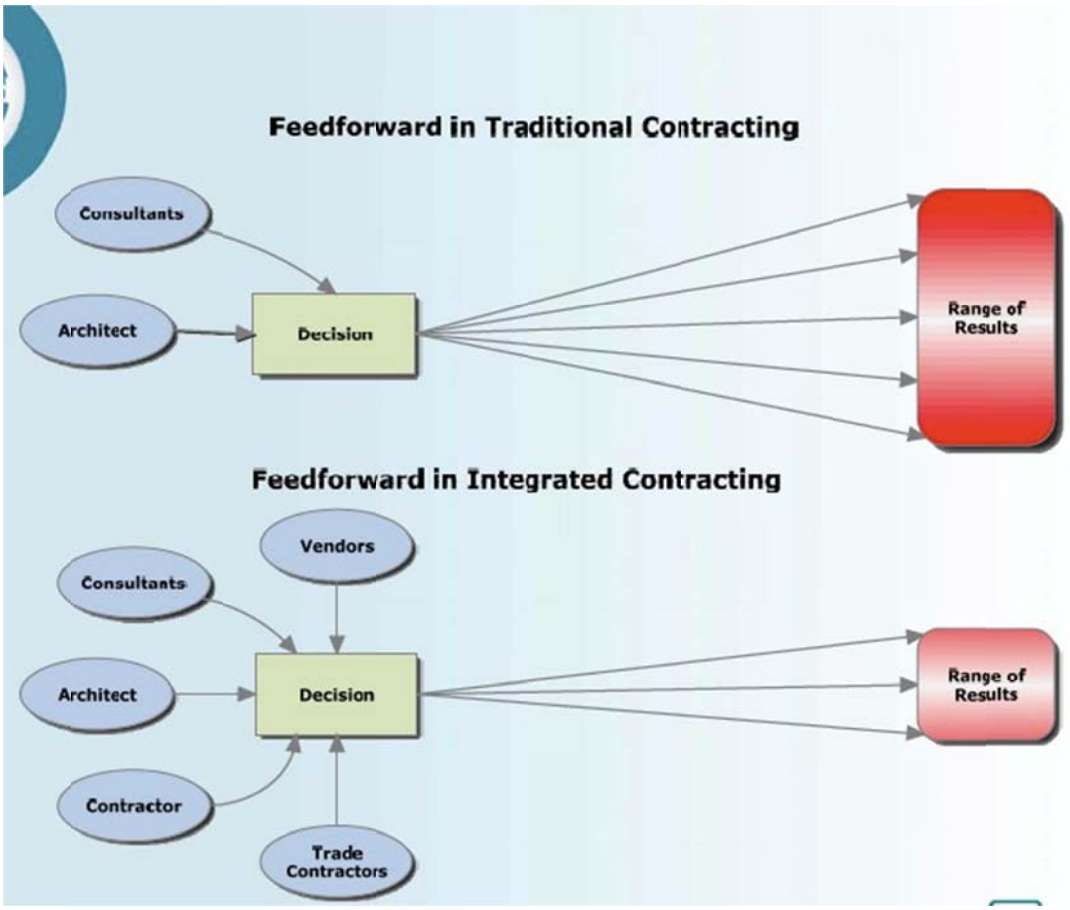

Figure 6-4: The feed forward in traditional contracting vs. integrated contracting (Howard)

In conclusion, IPD and all the possible technologies that can be used as tools for information delivery help the project parties to improve their communication in all the project phases and levels. Therefore, the contractor will have much better coordination with the project parties, there will be less change in the scope of the project during construction, the owner will be able to make quicker decisions, and the entire project will be completed in a manner that most closely resembles what the project parties planned and scheduled.

Chapter 7: Results and Observations

There are many professionals in the United States who believe that IPD will be the best delivery system if it is implemented correctly in the construction industry. “There is no doubt: IPD and LEED go hand in hand – and in many ways represent the future of the construction industry – as the industry evolves towards high performance construction of high performance buildings” (Ding N.D). Nevertheless, those who implement the process of IPD as a delivery system and all the tools required to use it should be aware of the following observations:

The IPD delivery system can eliminate the major causes of construction project delay in Saudi Arabia.

The recommendations to eliminate the construction project causes of delay in Saudi Arabia mentioned in Chapter 5 were used in IPD as a part of the IPD process.

The project parties should have enough resources to implement the IPD delivery system.

IPD requires many tools that the project parties should consider and implement such as BIM and other technologies that help to improve the quality of communication, coordination, and involvement of the project teams. Some of these resources and tools require training to use them. Also, implementing IPD for the first time demands that project parties share risks and are willing to try a new delivery system. A survey designed by David Kent and Burcin Becerik-Gerber mentioned the resistance to change that some of the construction parties had when they were asked if they would try IPD. However, around 97% of the respondents in an informed group in the U.S. construction industry said that they would be interested in working on a project that used IPD as a delivery method. Moreover, more than 66% if the respondents who have had experience with IPD believe more strongly than those who have not had this experience that IPD will be used widely in the future. (Kent 2010)

Leaders in the construction industry in Saudi Arabia should work on implementing IPD to encourage other organizations to use it. Saudi ARAMCO has played an important role in the construction industry by undertaking many large construction projects in the nation and by requiring a standard and building codes from the contractors involved in these projects. Many organizations have been known as “ARAMCO’s contractors.” They are independent contractors who have all the resources and qualifications that ARAMCO required to award them the construction projects. Also, there are many designers in Saudi Arabia that are

involved in ARAMCO projects and understand all the requirements of the organization. Therefore, ARAMCO could play an important role again in promoting IPD as a delivery method to organizations in the Saudi construction industry.

IPD does more than help in completing the construction on time

IPD offers many other benefits to project parties besides completing the projects as scheduled and on time. IPD can help the project team to apply the Lean principles that help to maximize value and minimize waste in the production process. (Singleton 2010)

Also, IPD helps to create high performing teams. “One IPD technique is to create cross functional team consisting of individuals from different companies who are assigned to work based upon their strength and project needs. In essence, IPD allows the flexibility to maximize each person’s productivity by putting the right person in the right job” (Singleton 2010; Thomsen, et al., 2010).

Moreover, IPD helps the project team to make “greener” and sustainable buildings and apply the LEED principles and get LEED certificates for their projects. “The collaborative impact of IPD not only makes IPD preferable to traditional delivery methods, it makes it necessary to harness the opportunity LEED presents to create incredibly sustainable buildings. LEED is not simply about scoring forty points to achieve basic certification. LEED represents an opportunity for owners, designers and builders to work together towards the common goal of creating great, sustainable buildings” (Ding N.D.).

Finally, IPD forces the project parties to take their responsibilities

seriously. All the project parties use their efforts and resources because they are working as a team that will share the project risks and awards. “The advantage of [IPD’s] information management is that the biggest focus of the project now becomes using and sharing information. It is no longer the litigious arena that architects and contractors have played in for decades but rather a new platform that effectively challenges the knowledge base and experience of a project team by making focus understanding and early issue resolution, as opposed to profession-focused concerns” (Brad 2009). In this system, the project parties are no longer working individually, so it is more helpful for them to trust each other and share all the information and experiences needed for the project. “IPD cannot exist without a true desire between the parties to work together and to put the needs of the projects above all others” (Singleton 2010).

Chapter 8: Conclusion and Recommendations

Currently, delay in construction project completion is a serious concern in Saudi Arabia. Several research papers have been published to find out the causes of construction project delay in the country. In this paper, 17 major causes were selected and classified into four categories: Bidding-Related factors, Financial-Related factors, Contract and Specification-Related factors, and Communication and Coordination-Related factors. In addition, recommendations were made to resolve these causes. Integrated Project Delivery (IPD) as a delivery method was analyzed to determine if it could fulfill those recommendations effectively. The analysis shows that IPD applied to those

recommendations in the early phases of the project can effectively help in finishing a construction project as scheduled with the desired quality. One issue, however, needs to be considered when implementing IPD in the construction industry of Saudi Arabia. The project parties should have enough resources to be involved in the IPD project. The companies that are leaders in the construction industry can encourage the other organizations to implement IPD.

Other benefits of IPD were found that could attract organizations in the construction industry to use it. First, IPD can apply the Lean and LEED principles to the project. Also, IPD encourages all the project parties to share the risks and rewards of the project and helps to create high performing teams.

Suggestions for further studies

This paper determined the major causes of construction project delays in Saudi Arabia and how IPD can be used to eliminate those causes. Further investigation is needed for several research questions such as, what are the challenges of implementing IPD in the construction industry in Saudi Arabia? The level of awareness about IPD in Saudi Arabia could be low. Therefore, the challenges of convincing the organizations in the construction industry, including the government, could be huge.

If leading organizations in Saudi Arabia have awareness of IPD, other questions would be raised: What types of contracts should be used? Will the IPD-related contracts used in the United States be useful in Saudi Arabia?

In addition, detailed case studies could be done on previous integrated delivery projects in Saudi Arabia, if there are any, or studies could be conducted on projects in a country that has a similar culture such as the United Arab Emirates. One project that could be used as a case study is King Abdullah University of Science and Technology (KAUST). The project was huge (3,600 hectares) and finished in nine months. Another future project that might use IPD is the expansion of the holy mosque in Makkah. On August 2011, King Abdullah bin Abdulaziz approved the new expansion project of 400 thousand square meters to be completed within three years. (King Abdullah et. 2011)

Finally, no standard model was found for implementing IPD. A proposal model based on successful previous IPD projects could be designed that considers the culture and characteristics of the Saudi construction industry.

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Appendix

Importance index and rank by Saudi Arabia respondents					
No	Causes of delay	RNK	Ctg	IW	R
29	Difficulties in financing the project by the contractor	1	C/PF	218	39
30	Cash flow problems faced by the contractor	2	C/PF	220	40
43	Delay in the settlement of contractor claims by the owner	3	OWN	216	40
23	Ineffective planning and scheduling of the project by the contractor	4	C/PM	203	38
15	Contractor's poor coordination with the parties involved in the project	5	C/PM	211	40
25	Ineffective control of project progress by the contractor	6	C/PM	188	36
4	5Changes in the scope of the project	7	EP	203	39
49	Delay in progress payments by the owner	8	OWN	202	39
14	Poor communications by the contractor with the parties involved in the project	9	C/PM	200	39
46	Slow decision making by the owner's organisation	10	OWN	210	41
31	Problems between the contractor and his subcontractors with regard to payments	11	C/PF	199	39
19	Poor controlling of subcontractors by contractor	12	C/PM	188	37
13	Shortage of technical professionals in the contractor' s organization	13	C/PM	193	38
21	Poor qualifications of the contractor's technical staff assigned to the project	14	C/PM	185	37
10	Low skill of manpower	15	C/MP	193	39
22	Improper technical studies by the contractor during the bidding stage	16	C/PM	181	37
27	Delay in the preparation of contractor submissions	17	C/PM	181	37
60	Government tendering system requirement of selecting the lowest bidding contractor	18	GR	181	37

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Table 1. Involvement of Project Team Members during Stages of a Project

	Preliminary design (%)	Early design (%)	Design development (%)	Construction (%)	Closeout (%)	Facility management (%)
Owner	94.3	85.8	84.9	82.1	72.6	71.7
Architect	92.3	89.4	92.3	82.7	67.3	15.4
Engineers	71.0	86.9	91.6	85.0	60.7	19.6
General contractor	46.7	69.2	82.2	89.7	76.6	23.4
Subcontractors	17.1	41.9	72.4	89.5	67.6	22.6
Manufacturers/suppliers	11.8	41.2	74.5	87.3	48.0	23.5
Specialty consultants	43.1	69.6	83.3	79.4	46.1	28.4

Table 3
Importance of delay causes

S. no.	Owners	Contractors	Consultants
1	Shortage of labors	Delay in progress payments by owner	Type of project bidding and award
2	Unqualified work force	Late in reviewing and approving design documents by owner	Shortage of labors
3	Ineffective planning and scheduling of project by contractor	Change orders by owner during construction	Delay in progress payments by owner
4	Low productivity level of labors	Delays in producing design documents	Ineffective planning and scheduling of project by contractor
5	Hot weather effect on construction activities	Late in reviewing and approving design documents by consultant	Change orders by owner during construction
6	Conflicts encountered with sub-contractors' schedule in project execution	Difficulties in financing project by contractor	Low productivity level of labors
7	Poor site management and supervision by contractor	Mistakes and discrepancies in design documents	Difficulties in financing project by contractor
8	Inadequate contractor's experience	Late procurement of materials	Poor site management and supervision by contractor
9	Effects of subsurface conditions (soil, existing of utilities, high water table, etc)	Inflexibility (rigidity) of consultant	Poor qualification of the contractor's technical staff
10	Change orders by owner during construction	Slowness in decision making process by owner	Delay in material delivery

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TABLE 1. Common Interface Problems According to Construction Parties' Viewpoint

Interface problems (1)	Responses					Mean (7)	Importance index (%) (8)
	Very strongly affects (2)	Strongly affects (3)	Moderately affects (4)	Strongly doesn't affect (5)	Very strongly doesn't affect (6)		
Financial problems	**68**	**176**	**113**	**34**	**6**	**2.67**	**66.8**
Delay in progress payment by owner	26	39	31	5	1	2.82	70.6
Accuracy of project cost estimate	14	55	27	5	0	2.77	69.3
Owners low budget for construction relative to requirement	21	53	22	5	1	2.77	71.6
Prices change of materials and laborers during construction	7	29	33	19	4	2.07	51.6
Inadequate contract and specification	**71**	**206**	**193**	**39**	**0**	**2.61**	**65.3**
Insufficient working drawing details	13	39	43	7	0	2.57	64.2
Insufficient specification	11	44	41	6	0	2.59	64.7
Violating conditions of the contract	5	13	4	0	0	3.05	76.14
Poorly written contract	10	42	35	14	0	2.48	61.9
Change order	11	30	50	11	0	2.40	60.0
Environmental problems	**14**	**30**	**92**	**63**	**5.5**	**1.93**	**48.2**
Weather	4	11	49	36	2	1.79	44.9
Geological problems at site	10	19	43	27	3	2.06	51.5
Other common problems	**106**	**325**	**309**	**67**	**7**	**2.56**	**64.4**
Lack of communication between construction parties	10	38	47	7	0	2.54	63.5
Slowness of owner in decision making	13	47	32	8	1	2.62	65.6
Delay in finish of project	9	38	42	13	0	2.42	60.5
Unavailability of professional construction management	7	28	48	17	2	2.2	55.2
Skills and productivity of laborers	15	40	43	40	0	2.65	66.2
Poor quality of work	18	52	28	3	1	2.81	70.3
Poorly done planning and scheduling	16	38	24	5	1	2.62	65.4
Unfamiliarity with local laws of related governmental agencies	18	44	27	10	2	2.65	66.3

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